

Use of Waste Plastic in Bitumen Road Construction

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Abstract— Nowadays, plastics are used in our day-to-day life for enormous purposes viz. carry bags in various shops, milk bags from households, disposable cups from events are major plastic wastes. Plastic is a toxic & persistent material. It is generally found to be nearly 5% in Municipal Solid Wastes (MSW), which is a major environmental threat. Plastic is non-degradable material and remain in ecosystem for 1000 years. Plastic materials clog waterways, drainage and oceans and entangles marine life. Many animals eat plastic materials and die. Waste plastic bags and waste plastic materials interrupt the infiltration and percolation of rain water through soil pores and in turn diminishes the ground water. There are so many institutes which after consistent researches have come to a conclusion that waste plastics can be used in modifying roads. If we use plastics in road construction, we can reduce the cost of road construction and pollution index of environment to an appreciable extent. We can use plastics as binder with bitumen. It may give better finish-ability, stability, binding property, resistance to water and durability. It is economical and eco-friendly.

I. INTRODUCTION

Plastic are user friendly but not eco-friendly as they are non-biodegradable. Today in INDIA nearly more than 12 million tons of plastics are used. Their visibility has been perceived as a serious problem and made plastic a target in the management of solid waste. They also have a very long lifetime and burning of plastics waste under uncontrolled conditions could also lead to generation of many hazardous air pollutant (HAPs) depending upon the type of polymers and additives used. Plastic modified bitumen is emerging as one of the important materials for construction of flexible pavement. The polymer modified bitumen shows better properties for road construction and plastic waste, can find its use in this process and this can help solving problem of pollution. The better binding property of plastic in its molten state has helped in finding out a method of safe disposal of waste plastic. Roads surface with neat bitumen can cause bleeding in hot climate, may

develop cracks in cold climate, possess fewer load bearing capacity and can cause serious damages because of higher axial load in present conditions due to rapid infrastructure development. India has to raise transportation system to a higher level both in terms of length and quality. The use of waste plastic materials in hot bituminous mixes enhance pavement performance, protect environment and provide economical and eco-friendly roads.

II. OBJECTIVE

Basic intention behind this research is to utilize the waste plastic efficiently in a constructive way such that it proves to be useful to the society.

Main objectives of this project work are:

- Testing on strength and durability of the plastic bitumen mixture and compare with the conventional mixture.
- To compare advantages and disadvantages of waste plastic asphalt mixture in road construction.
- To select an optimum waste plastic content for the mixture after the analysing the test results.

III. LITERATURE REVIEW

- Dr. R. Vasudevan (2007) stated that the polymer bitumen blend is a better binder compared to plain bitumen. Blend has increased softening point and decreased Penetration value with a suitable ductility.
- Verma S.S. (2008) studied the utilization of waste plastic as modifier for bitumen in road construction. Food packet wrappers, cold drink bottles and other plastic waste create environmental problems. Plastic materials are made up of various chemical elements and is non degradable. Waste plastic is made up of polyethylene, polypropylene and polystyrene.

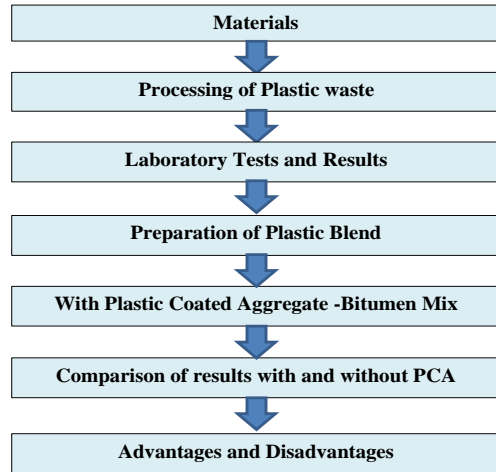
Softened plastic can be coated over aggregate and can be used in road construction. It increases strength and durability of the road.

- P. Sreejith (March,2010) Polymer modified bitumen is emerging as one of the important constructions of flexible pavements. The polymer modified bitumen show better properties for road construction and plastics waste can find its use in this process and this can help solving problem of pollution. The studies on the thermal behaviour and binding property of molten plastics promoted a study on the preparation of plastic waste-bitumen blend and its properties to find the suitability of the blend for road construction.
- Pada Sabtu (2010) compared properties of the modified bitumen with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12% by weight. The softening point of the modified bitumen increased with the addition of plastic additive, up to 8.0 %by weight. Studies were carried out on Bituminous mixes using 60/70 grade bitumen having average Marshall Stability Value (MSV) of 1300 kg at optimum bitumen content of 5.0 % by weight of the mix.
- Amit Gawande, et. al (Zambre, Renge) March,2012 stated that the concept of utilization of waste plastic in road construction has been done since 2002. Conventional roads have poor resistance towards water also it has low strength and durability. We can enhance these properties by blending the bitumen with plastic waste.

IV. PROPOSED METHODOLOGY

In order to achieve the objectives of the study, a thorough review is done to have knowledge of the works available in literature. First of all, collection of plastic waste can be done. After that shredding or cutting of plastic into small pieces can be done. After that ordinary test can be performed on aggregate and bitumen. After that using plastic waste coating of aggregate can be done and tests will be performed. After that plastic is mixed with bitumen and laboratory tests can be performed. At last comparison

of both test results with and without plastic waste can be done.



(fig. Schematic flow diagram of methodology)

PREPARATION OF DESIGN MIX

Plain Bituminous Mix:

Bitumen is a black, oily, viscous material that is a naturally-occurring organic byproduct of decomposed organic materials. Also known as asphalt or tar, bitumen was mixed with other materials throughout prehistory and throughout the world for use as a sealant, adhesive, building mortar, incense, and decorative application on pots, buildings, or human skin. The material was also useful in waterproofing canoes and other water transport. A good design of bituminous mix is expected to result in a mix which is adequately (i) strong (ii) durable (iii) resistive to fatigue and permanent deformation (iv) Environment friendly (v) economical and so on.

Selection of Mix Constituents

Binder and aggregates are the two main constituents of bituminous mix. This section discusses some of the issues involved in selection of binder and aggregates.

Binders

Generally, binders are selected based on some simple tests and other site-specific requirements. These tests could be different depending of the type of binder viz. penetration grade, cutback, emulsion, modified binder etc. For most of these tests, the test conditions are pre-fixed in the specifications. Temperature is an

important parameter which affects the modulus as well as the aging of binder.

Aggregate

Number of tests is recommended in the specifications to judge the properties of the aggregates, e.g., strength, hardness, toughness, durability, angularity, shape factors, clay content, adhesion to binder etc. Angularity ensures adequate shear strength due to aggregate interlocking, and limiting flakiness ensures that aggregates will not break during compaction and handling.

Coated Bituminous Mix:

The generation of waste plastics is increasing day by day. The major polymers are namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state. The plastic-coated aggregate bitumen mix and plastic modified bitumen forms better materials for flexible pavement construction as the mixes shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods of easy disposal of waste plastics.

MIXING BY MINI HOT MIX PLANT:

Step I: Plastic waste made out of PE, PP and PS cut into a size between 2.36mm and 4.75mm using shredding machine.

Step II: Similarly, the bitumen is to be heated to a maximum of 1600C to have good binding and to prevent weak bonding. (Monitoring the temperature is very important)

Step III: At the mixing chamber the shredded plastic waste is to be added to the hot aggregate. It gets coated uniformly over the aggregate within 30 Secs, giving an oily look Plastic coated aggregate is obtained

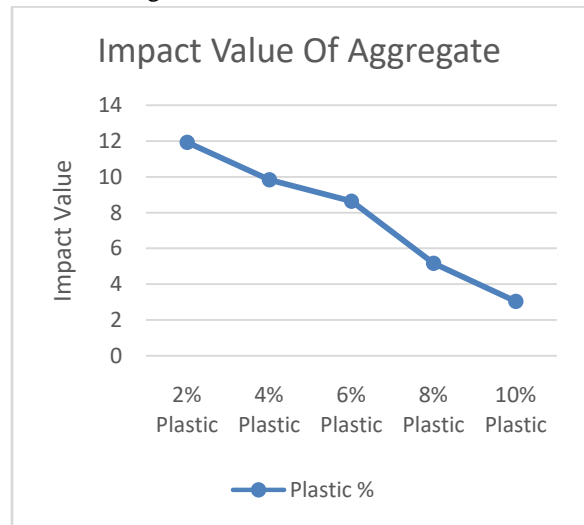
Step IV: Hot bitumen is then added over the plastic-coated aggregate and the resulting mix is used for road construction. The road laying temperature is between 1100C to 1200C. The roller used is 8-ton capacity.

V. RESULTS AND DISCUSSION

On the basis of above methodology, various aspects regarding the Polymer coated aggregates are being discussed below:

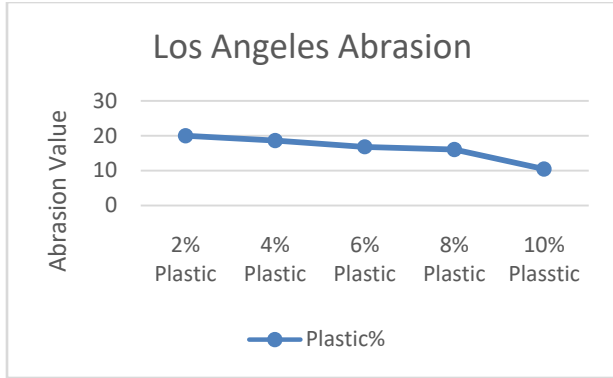
A. Aggregate Impact Value:

The test is used to determine the aggregate’s resistance to fracturing. It measures the ability of the road to resist impact or to measure how tough the road is. Continuous movement of heavy vehicles on the road subjects them to nonstop impact causing it to disintegrate. In order to measure this a sample of the mixture is taken and hit with a 14 kg hammer 15 times. The % of mass that becomes powdered should not exceed 30%. The powdered mass will be identified as the mass passing through a 2.36mm sieve. The experiment was conducted for 2%, 4%, 6%, 8% and 10% of plastic and the results were found to be 11.93%, 9.83%, 8.64%, 5.17% and 3.04% respectively. This suggests that the plastic makes the mixture less susceptible to fracturing in the event of a large force.



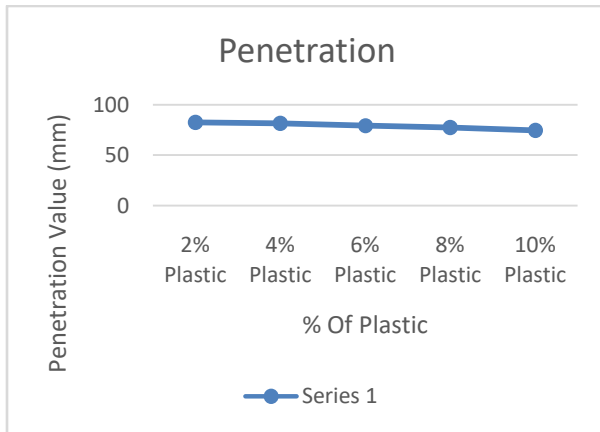
B. Los Angeles Abrasion Value:

The test used is the Los Angeles abrasion test. This test measures how resistant the aggregate used in the road is to abrasion. Soil particles present in the tyres of the vehicles and the on the road result in abrasion of the road as the vehicles move on the road. This test measures whether the road aggregate is hard enough to withstand abrasion. The % mass passing through the sieve should be less than 30%. The experiment was conducted for 2%, 4%, 6%, 8% and 10% of plastic and the % mass passing through the sieve were found to be 20.2, 18.64%, 16.84%, 16.6% and 10.44% respectively.



Penetration Test:

The test determines the hardness of bitumen by measuring the depth (one tenths of a mm) to which a standard, and loaded needle will vertically penetrate in 5 seconds, in a sample of bitumen maintained at a temperature of 25⁰ C. The test was carried out in accordance with the procedure laid down in IS: 1203–1978



VI.CONCLUSION

The aim of the study was to utilize the waste materials i.e., plastic wastes for mass scale utilization such as in highway construction in an environmentally safe manner.

1. It is observed that the penetration values of plain bitumen decrease on increase of the plastic mix content. The results also show that the addition of plastic makes the modified bitumen harder and more consistent than plain bitumen which results in improvement in the rutting resistance of the mix
2. It is observed that the ductility of plain bitumen increases with the addition of PET from 2-12% whereas, the ductility value declines at 14% PET addition. The increase in the ductility value may be

due to interlocking of polymer molecules with bitumen, while decline in ductility value after 12% might be due to excess plastic waste which makes bitumen stiffer

3.The coating of plastics improves Aggregate Impact Value, thus improving the quality of the aggregate. Moreover, a poor quality of aggregate can be made useful by coating with polymers. It helps to improve the quality of flexible pavement. This shows that the toughness of the aggregate to face the impacts

6. The aggregate with lower crushing value indicate a lower crushed fraction under load and would give a longer service life to the road. Weaker aggregate would get crushed under traffic load. It is clearly seen from result Table- that plastic coated aggregates shows the lower crushing value and which can be withstand to traffic load more efficiently than the plain aggregates. Its range should be less than 30-35%.

7. Los Angeles Abrasion test gives that wear and tear in percentage. Under this study the percentage of wear and tear values of plastic-coated aggregate is found to be in decreasing order with respect to the percentage of plastics. When the Los Angeles abrasion value of plain aggregate value is compared with the plastic-coated aggregates the values are less for coated aggregates. The results obtained are within the range hence can be used for the construction. Its range should be less than 35%

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